Effects of Shadowing and Illumination on Planet Formation

Hannah Jang-Condell
Department of Terrestrial Magnetism
Carnegie Institution of Washington
5241 Broad Branch Road, NW, Washington, DC 20015
USA
hannah@dtm.ciw.edu

Radiative transfer is an important process in protoplanetary disks. Stellar illumination, in particular, is primarily responsible for setting the temperature and density structure of protoplanetary disks. These disk conditions can profoundly affect the properties of the planets that form in the disks. Perturbations in the disk structure such as clumping, gap-opening, and dust-settling can create shadows and bright spots that in turn further perturb the disk's structure. Density and temperature variations resulting from the dynamical interactions between a planet and a disk can be further enhanced by these cooling and heating effects, leading to alterations in planetary migration rates, planetary growth, and other important planet formation processes. I present radiative transfer calculations on a three-dimensional disk perturbation induced by a protoplanet embedded in a disk and estimate the amount of heating and cooling that result from shadowing and illumination on the disk's surface. These temperature perturbations can affect ice formation, which in turn affects the accumulation of water onto a planet embryo as well as the growth rate of protoplanets. The change in the local pressure gradient caused by these temperature perturbations also changes the migration rate of the planet. I will also address some possible observational signatures of the presence of planets in disks. Small planets that are insufficiently massive to open a full annular gap in the disk are likely to be out of the range of observability, but gaps with large extent may be detectable in images and spectral energy distributions.